

Population Consequences of Acoustic Disturbance of Blainville's Beaked Whales at AUTECH

Diane Elaine Claridge & Charlotte Ann Dunn
Bahamas Marine Mammal Research Organisation
P.O. Box AB-20714
Marsh Harbour
Abaco, Bahamas

phone: (242) 366-4155 fax: (242) 366-4155 email: dclaridge@bahamaswhales.org
phone: (242) 366-4155 fax: (242) 366-4155 email: cdunn@bahamaswhales.org

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LONG-TERM GOALS

Atypical strandings and behavioral responses of beaked whales have been associated with the use of Navy mid-frequency active (MFA) sonar (e.g. Simmonds and Lopez-Juraco 1991, Evans and England 2001, McCarthy et al. 2011, Tyack et al. 2011). Yet MFA sonar operations occur repeatedly on Navy ranges that are known beaked whale habitat. The Bahamas Marine Mammal Research Organisation (BMMRO) has been studying beaked whales in the northern Bahamas (Claridge 2006), including a population of Blainville's beaked whales (*Mesoplodon densirostris*) found at the Atlantic Undersea Test and Evaluation Center (AUTECH) range. These data are providing critical information on abundance, survival, and reproductive rates which are being used to model the population consequences of acoustic disturbances at AUTECH. The long-term goal of this project is to develop a methodology for monitoring the long-term health of populations that are repeatedly exposed to sonar. This work is important for the continued operational integrity of Navy ranges.

OBJECTIVES

The overall objective of this study is to develop a methodology for evaluating and monitoring the health of beaked whale populations on navy ranges and to apply this to Blainville's beaked whales at AUTECH. The specific objectives for BMMRO are to analyze longitudinal data to investigate aspects of the life history and behavior of this species which will be needed to inform the population consequences model, thus forming part of a larger project, Population Consequences of Acoustic Disturbance (PCAD, for full details of the project, see the PCAD Working Group reports).

APPROACH

The PCAD model is based on a framework (Figure 1) developed by the National Research Council (NRC) Committee on Characterizing Biologically Significant Marine Mammal Behavior (NRC 2005).

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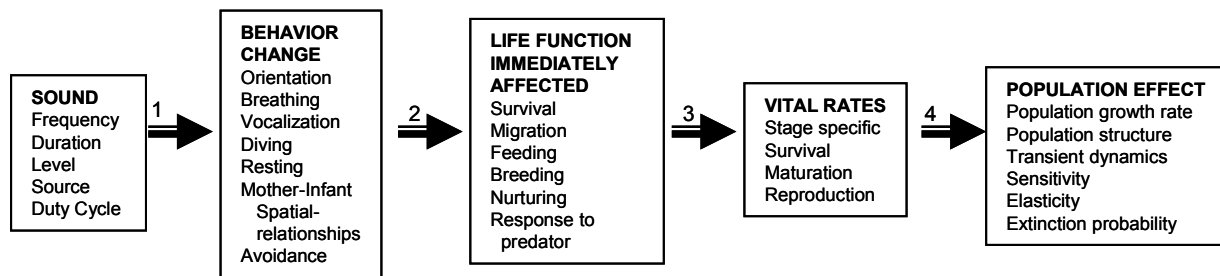


Figure 1: The PCAD (Population Consequences of Acoustic Disturbance) framework (NRC 2005).

The ONR PCAD Working Group are developing the beaked whale PCAD model using a model structure similar to that used for elephant seals, which have a similar diving behavior to beaked whales. This model links changes in diving behavior to changes in body condition, and changes in body condition to vital rates (particularly calf survival and pregnancy). The key components of the model to which BMMRO is contributing through funding sponsored by this grant are the following:

1. **Mother-infant spatial relationships:** investigation of the diving and vocal behavior of mother-calf pairs using a combination of visual observations and acoustic detections. The primary question of interest is whether young calves are capable of diving for the same durations and to the same depths as their mother which will provide useful baseline mother-infant spatial relationships.
2. **Maturation:** analysis of longitudinal individual sightings data to determine age at sexual maturity, as well as the age at which calves first separate from the mother.
3. **Reproduction:** investigation of life history data to provide estimates of inter-calf interval and calf survival.

Analyses through other funding opportunities (e.g. N000140710120) are contributing to additional model parameters such as adult survival, age composition of the population, population growth rate and population structure. These are key parameters in determining the risk of extinction for a local population (Lande 1993).

WORK COMPLETED

Preliminary analyses were started for components 1 and 2 listed above. To determine if the diving behavior of calves mirrors that of their mother, acoustic recordings of click detections at AUTECH were analyzed. If both mother and calf are detected clicking during a foraging dive, then click duration and in some cases, dive depth, can be determined. The first step was to look at the age at which Blainville's beaked whales start clicking. To date, there have been only two encounters during which the group composition was made up solely of a female with a young calf whilst on the AUTECH hydrophone array and when acoustic recordings were made. The first encounter was on the 1st October 2008; the animals were first detected on the hydrophone array and then later, group composition was confirmed visually. Good quality recordings were made from four hydrophones over a 45-minute period while the pair was diving, prior to surfacing. Upon surfacing, the calf was noted to be a neonate, less than 2 months of age.



Figure 2: Adult female Blainville's beaked whale with neonate calf photographed on October 1st, 2008 at AUTC. The pair had surfaced from a foraging dive during which acoustic recordings were made.

The second encounter was on the July 25th, 2012 and again detections were first made on the hydrophone array and then the animals were sighted. This calf was estimated as 3-4 months old and was observed nursing. Although recordings were made, the recordings made during this encounter are not yet available for analysis.



Figure 3: Adult female Blainville's beaked whale with young calf photographed on July 25th, 2012 at AUTC. After visual observations were made and the pair was photographed, they began a foraging dive during which acoustic recordings were made.

To address components 2 and 3 (listed above), analyses of photographs of individual Blainville's beaked whales were carried out to assign age and sex classes to individuals throughout the sighting record. This is an important initial step before age can be assigned. Only those individuals that were seen on more than one occasion were included, resulting in 650 observations of 76 individuals (Table 1). Although there are no results to report until the data are explored more thoroughly, preliminary analyses of the photographic data show sufficient data exist to determine age at sexual maturity, weaning or separation from the adult, as well as inter-calf interval.

RESULTS

When do Blainville's beaked whales start clicking? Preliminary acoustic analysis for the encounter on October 1st, 2008 found only a single animal clicking at any one time in all recordings. Further planned work will analyze the clicks in relation to other recordings of adult females, to determine if the clicks are from the mother, and only the mother. There were no other beaked whales encountered visually or detected on the AUTC hydrophone range within two hours of this encounter, and within a three-hydrophone radius around the focal area (equivalent to six nautical miles distance). Interestingly, analysis of recordings of an adult female with an older calf, noted as a juvenile (2-4 years old) also on

October 1st, 2008. In these recordings, there were clearly two animals clicking. Further analysis will look for differences between the mother and the juvenile's clicks.

Table 1. Summary of preliminary data for 76 individual Blainville's beaked whales that were assigned to a specific age, and when possible sex, category between 1997 and 2011. Categories are: N = neonate, C = calf, J = juvenile, UI = unknown immature, SM = subadult male, SF = subadult female, AM = adult male, and AF = adult female. Lag time is the time in years between the first and last sighting record, and the number of sightings were counted by encounter-day. Individuals that were monitored from calf to post-separation from the mother have a bold X in the UI column. Individuals monitored from calf until mature are highlighted (females in red, males in blue).

IDs	Age & sex category							Lag time (years)	No. sightings
	N	C	J	UI	SM	SF*	AM		
Md067							X	5.30	5
Md068							X	3.15	2
Md069							X	14.07	6
Md070							X	11.00	29
Md071							X	4.15	9
Md072		X	X					0.90	2
Md073	X	X	X	X				3.06	10
Md075							X	8.80	25
Md076							X	12.82	41
Md078							X	5.51	14
Md079							X	7.05	14
Md091							X	12.94	9
Md094							X	13.09	39
Md106							X	8.38	29
Md107			X	X		X	X	11.83	11
Md111							X	2.60	2
Md112							X	9.85	4
Md115	X	X	X	X	X			8.01	13
Md121				X		X	X	12.43	10
Md129				X		X	X	3.22	4
Md130					X		X	12.00	6
Md132							X	1.49	2
Md133							X	2.29	14
Md134		X	X	X		X	X	12.04	24
Md135		X	X	X		X	X	12.03	20
Md138							X	3.06	4
Md139							X	11.88	8
Md141							X	11.46	36
Md142		X	X					2.34	22
Md143		X	X	X	X		X	11.44	22
Md144							X	7.72	2
Md150							X	2.89	9
Md151		X	X					1.54	18
Md152					X			4.29	3
Md155				X		X	X	4.03	4
Md156							X	7.22	2
Md160							X	7.22	2
Md163							X	10.76	2

IDs	Age & sex category							Lag time (years)	No. sightings
	N	C	J	UI	SM	SF*	AM		
Md167		X	X					1.38	8
Md170				X	X			6.16	3
Md172					X			1.57	2
Md179							X	0.83	3
Md180			X					1.88	4
Md181							X	2.52	3
Md183		X	X			X	X	6.15	4
Md184							X	4.04	2
Md185							X	3.07	3
Md190		X	X	X		X	X	8.43	15
Md191		X	X	X				6.25	10
Md193							X	4.76	3
Md194				X		X	X	4.04	2
Md196				X		X	X	8.22	11
Md197		X	X	X				4.77	8
Md198		X	X	X				6.00	13
Md200							X	0.32	2
Md201							X	0.64	3
Md202		X						0.12	2
Md203							X	0.12	2
Md208					X			3.75	3
Md209							X	5.82	8
Md211							X	3.99	6
Md213							X	1.01	2
Md214	X	X		X				4.96	4
Md217			X	X				2.48	4
Md219					X			2.04	3
Md221							X	0.40	2
Md238							X	2.18	2
Md242							X	1.15	4
Md244			X					0.06	3
Md245	X	X						1.01	3
Md246		X	X					1.02	4
Md248		X	X					0.79	5
Md249		X						0.33	4
Md250		X						0.48	4
Md297	X							0.05	4
Md298	X							0.05	4

IMPACT/APPLICATIONS

Measuring the health of populations utilizing Navy ranges has more relevance to the Navy than simply monitoring their size. This program focuses directly on that goal and represents the first attempt to

combine data from various sources (visual, tag, biophysical, and passive acoustic data) for this purpose, including the long-term photo-identification and behavioral data provided by BMMRO. Using these data sets and expertise, a methodology is being developed for evaluating the population level effect of sonar on Blainville's beaked whales in The Bahamas. This will be valuable to apply to other beaked whale species and in other locations, e.g. Cuvier's beaked whales, a priority species, at the Southern California Offshore Range (SCORE).

RELATED PROJECTS

Assessing Beaked Whale Reproduction and Stress Response Relative to Sonar Activity at the Atlantic Undersea Test and Evaluation Center (AUTEC)

This project is a collaborative project between BMMRO, Southwest Fisheries Science Center (Nick Kellar, John Durban) and the Naval Undersea Warfare Center (David Moretti). The goal of this study is to assess glucocorticoid levels from blubber biopsies of targeted species, to assess stress levels relative to sonar exposure. Specifically, the project aims to collect biopsy samples at AUTEC where fleet readiness training involves regular use of mid-frequency active sonars, and compare the levels to those measured in biopsies collected from control populations within the Bahamas region that are less exposed to sonar activity. In parallel, pregnancy states will be ascertained via blubber progesterone levels in both groups of animals to investigate whether there is a relationship between sonar activity, stress measures, and reproductive rates, to assess population-level impacts.

Monitoring beaked whale movements during the Submarine Commanders Course using satellite telemetry

This project is a collaborative project between the Bahamas Marine Mammal Research Organisation, Southwest Fisheries Science Center and the Naval Undersea Warfare Center (David Moretti). Satellite telemetry is being used to monitor the movements and diving behavior of beaked whales and other odontocete cetacean species on the US Navy's AUTEC range before, during and after sonar exercises in which multiple ships are using their tactical sonars. Field work during this project is providing opportunity to collect biopsy samples and photo-identification data at AUTEC. This project has been supported by the US Department of Defense (OPNAV N45 - Environmental Readiness Division).

Behavioral ecology of deep-diving odontocetes in the Bahamas

This project is examining key aspects of the behavioral ecology of six Department of Defense priority species in The Bahamas. We will integrate data acquired through individual photo-identification, molecular genetics, fatty acid, persistent organic pollutant and stable isotope profiles, satellite telemetry and acoustic recordings to characterize the social structure, residency patterns, reproductive biology, diet, foraging ecology, and population structuring of key cetacean species. Field work during this project is providing opportunity to collect biopsy samples and photo-identification data from throughout the northern Bahamas. The project has been supported by the Strategic Environmental Research and Development Program (US Department of Defense, Department of Energy and the Environmental Protection Agency).

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